

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD**

IRRIGATION SYSTEM, MICRO IRRIGATION

(No. and Acre)

CODE 441

DEFINITION

An irrigation system for distribution of water directly to the plant root zone by means of surface or subsurface applicators.

PURPOSE

This practice may be applied as part of a conservation management system to support one or more of the following purposes:

- To efficiently and uniformly apply irrigation water and maintain soil moisture for optimum plant growth.
- To apply chemicals.

CONDITIONS WHERE PRACTICE APPLIES

On sites where the soils and topography are suitable for irrigation and proposed plants and where a micro irrigation system has been determined to be the most desirable method of irrigation.

Micro irrigation systems, including subsurface drip irrigation (SDI), shall consist of bubblers (generally < 60 gal/hr), drip or trickle emitters and tapes (generally < 2 gal/hr), or spray or spinners (generally < 45 gal/hr).

Micro irrigation is suited to orchard and row crops, windbreaks, gardens, greenhouse crops, and residential and commercial landscape systems and on steep slopes where other methods would cause excessive erosion or on areas where other application devices interfere with cultural operations.

CRITERIA

General Criteria Applicable To All Purposes

This practice must conform to all federal, state, and local laws and regulations. Laws and regulations of particular concern include those involving water rights, land use, pollution control, chemigation, property easements, wetlands, preservation of cultural resources, and endangered species.

The system shall be designed to uniformly apply water and/or chemicals directly to the plant root zone to maintain soil moisture within the range for good plant growth without excessive water loss, erosion, reduction in water quality, or salt accumulation.

Depth of application.

Net depth of application shall be sufficient to replace the water used by the plant during the plant peak use period or critical growth stage without depleting the soil moisture in the root zone of the plant below the management allowed depletion (MAD). Gross depth of application shall be determined by using field application efficiencies consistent with the conservation use of water resources.

Applications shall include adequate water for leaching to maintain a steady state salt balance. The net depth of application shall be expressed as inches per day per unit of design area.

$$F_n = 1.604 \frac{Q N T E}{A F}$$

Where: F_n = net application depth,
in/day/design area

Q = discharge rate, gal/hr/emitter

IRRIGATION SYSTEM, MICRO IRRIGATION (441)-2

N = number of orifices or emitters

T = hours of operation per day, 22 hours maximum

E = field application efficiency, expressed as a decimal, not greater than 0.90 for design purposes.

A = ft² of field area served by N (number of emitters)

F = the design area as a percentage of the field area, expressed as a decimal

1.604 = units conversion constant

System capacity. The system design capacity shall be adequate to meet the intended water demands during the peak use period for all plants to be irrigated in the design area, such as the requirements of selected irrigation events during critical growth periods when less-than-full irrigation is intended. Design capacity shall include an allowance for reasonable water losses (evaporation, runoff from spray or spinners, and deep percolation) during application periods. The system shall have the capacity to apply a specified amount of water to the design area within the net operation period.

For orchard crops, the design area may be less than 100 percent of the field area (A), but no less than the mature plant root zone.

The system should have a minimum design capacity sufficient to deliver the peak daily irrigation water requirements in 90% of the time available, but not to exceed 22 hours of operation per day. The rationale for using a design capacity less than the peak daily irrigation water requirement shall be fully explained and agreed upon by the end user. Field application efficiency (E) for design purposes shall not exceed 90 percent.

Emitter discharge rate. The design discharge rate of applicators shall be determined from manufacturer's data for the expected operating range. The discharge rate shall not create runoff within the immediate application area. For bubbler irrigation, a basin beneath the plant canopy is required for water control, with applications confined to the basin area.

Number and spacing of emitters. The number and spacing of emitters along the lateral line shall be adequate to provide water distribution to the plant root zone and percent plant wetted area (P_w). National Engineering Handbook (NEH), Section 15, Chapter 7, shall be used to determine the P_w .

Operating pressure. The design operating pressure shall be in accordance with manufacturer recommendations. The system operating pressure must compensate for pressure losses through system components and field elevation effects.

Emitter manufacturing variability. The manufacturer's coefficient of variation (C_v) shall be less than 0.07 for point source emitters, 0.10 for SDI emitters and less than 0.20 for line source emitters.

Allowable pressure variations.

Manifold and lateral lines. Manifold and lateral lines, operating at the design pressure, shall be designed to provide discharge to any applicator in an irrigation subunit (zone) operated simultaneously such that they will not exceed a total variation of the design discharge rate as listed below:

- 20 percent for deep rooted, low value crops
- 15 percent for shallow rooted, high value crops

Pressure shall conform to manufacturer's recommendations.

Main and submain lines. Main and submain lines shall be designed to supply water to all manifold and lateral lines at a flow rate and pressure not less than the minimum design requirements of each subunit.

Adequate pressure shall be provided to overcome all friction losses in the pipelines and appurtenances (valves, filters, etc.). Pipe sizes for mains and submains shall maintain flow velocities and emission uniformity (EU) within

IRRIGATION SYSTEM, MICRO IRRIGATION (441)-3

recommended limits as determined by procedures contained in NEH Section 15, Chapter 7.

Economic considerations shall include both installation and operating costs. Main and submain lines shall be designed and installed according to NRCS conservation practice standard Irrigation Water Conveyance, Pipelines, Code 430.

Filters. A filtration system (filter element, screen, strainer, or filtration) shall be provided at the system inlet. Under clean conditions, filters shall be designed for a head loss of 5 psi or less. For a self-cleaning filter in which head loss is created by orifice plates at the inlet of the filter, the allowable pressure loss across the filter for clean conditions shall be 8 psi or less.

The filter shall be sized to prevent the passage of solids in sizes or quantities that might obstruct the emitter openings. Filtration systems shall be designed to remove solids equal to or larger than one-fourth the emitter opening diameter, or the emitter manufacturer's recommendations, whichever is more stringent.

The filter system shall provide sufficient filtering capacity so that backwash time does not exceed 10% of the system operation time. Within this 10% time period, the pressure loss across the filter shall remain within the manufacturer's specification and not cause unacceptable emission uniformity (EU).

Filter/strainer systems designed for continuous flushing shall not have backwash rates exceeding 1.0% of the system flow rate or exceeding the manufacturer's specified operational head loss across the filter.

Pressure regulators. Pressure regulators shall be used where topography and the type of applicator dictate their use. Pressure regulators shall not be planned to compensate for improperly designed pipelines.

Chemical water treatment. Proper maintenance and water treatment shall be followed to prevent clogging based upon dripper and water quality characteristics. ASAE EP405.1 contains guidelines for chemical water treatment.

When placing chemicals in micro irrigation systems, all state and local laws, regulations, and permits will be obtained and followed.

System flushing. Appropriate fittings shall be installed above ground at the ends of all mains, submains, and laterals to facilitate flushing. A minimum flow velocity of 1.5 ft/sec is considered adequate for flushing.

Subsurface Irrigation. Tubing depth and spacing are soil and crop dependent. Emitter line depth shall consider the auxiliary irrigation methods used for leaching, germination, and initial development. Maximum lateral line distance from the crop row shall be 24 inches for high value annual row crops, 30 inches for grain crops and 48 inches for perennial (pasture/alfalfa), vineyard, and orchard crops. EU for the system (zone) shall be designed for a minimum of 85 percent. For individual lateral lines (hose) the EU shall not be less than: 88% for deep rooted, low value crops

- 92% for shallow rooted, high value crops

Water flow in the dripline shall be level to 2 percent downgrade with a maximum length of 660 feet. If these conditions are not met, the design shall be supported by engineering (hydraulic) documentation that show the EU for the system (zone) or individual lateral lines shall equal or exceed the values stated above.

A flush line shall be included at the outlet end of the lateral lines, with flush valves located on each end of the flush line. Pressure gauges or taps shall be included at the manifold inlet and flush line to monitor pressure drop or rise in the irrigation zone.

A method of air release shall be installed at the summit of the main and sub-main and end of flush lines to release air upon filling of the system. Vacuum relief valves shall be installed at the high points on the main, sub-main flush lines, and along the lateral lines as needed to relieve vacuum from developing during drainage and the potential plugging problem from soil being drawn into the emitters within the lateral tubing.

Chemigation. System and individual lateral line EU(s) shall not be less than those values stated above when fertilizer or pesticides are applied through the system.

IRRIGATION SYSTEM, MICRO IRRIGATION (441)-4

Injectors (chemical, fertilizer, or pesticides) and other automatic operating equipment shall be located adjacent to the pump and power unit, placed in accordance with manufacturer's recommendation, and include integrated back flow prevention protection.

Chemigation shall be accomplished in the minimum length of time needed to deliver the chemicals and flush the pipelines. Application amounts shall be limited to the minimum amount necessary, not to exceed maximum amounts recommended by the chemical label.

Chemigation shall conform to all state and local laws, regulations, and pesticide labels including the use of specialized chemigation and safety equipment, site permit, and operation certification.

CONSIDERATIONS

Where natural precipitation and/or stored soil water is not sufficient for germination, special provisions shall be made for germination; or the micro irrigation system shall apply water at a rate sufficient to adequately wet the soil to germinate seeds or establish transplants. The depth of a subsurface system for use on annual crops shall be limited by the ability of the system to germinate the seeds, unless it is stated in writing that other provisions will be made for this function.

Water quality is usually the most important consideration when determining whether a micro irrigation system is feasible. Well and surface water often contains high concentrations of undesirable minerals (chemicals). Surface water can contain organic debris, algae, moss, bacteria, soil particles, etc. Well water can also contain sand. The irrigation water supply shall be properly tested to determine feasibility and treatment needed for use in micro irrigation systems.

Micro irrigation can influence runoff and deep percolation by raising the soil moisture level and decreasing available soil water storage capacity, increasing the probability of runoff or percolation below the root zone from storm events. The movement of sediment, soluble chemicals, and sediment-attached substances carried by runoff may affect surface water quality. The movement of dissolved

substances below the root zone may affect groundwater quality.

Micro irrigation may affect downstream flows or aquifers and the amount of water available for other water uses.

Chemigation may or may not be required at the same time the plant requires irrigation, which may affect the economics of chemigation. Weather conditions should be considered before applying chemicals. Chemicals should not be applied if rainfall is imminent. Pest and nutrient management planning, following Nutrient Management – Code 590 and Pest Management – Code 595, should address the timing and rate of chemical applications.

Plugging of emitters by physical, chemical, or biological materials is the major cause of system failure. The filtration system is one of the most important components of a SDI system. Its operation and maintenance must be well understood by the irrigator to help ensure the longevity of the SDI system. Screen and sand media filters are used to remove the suspended solids such as silt, sand, organic debris, and inorganic debris from the water. Surface water often requires more extensive filtration than groundwater, but filtration is required for all systems.

On systems where chemicals are injected, care shall be taken so the injected nutrients do not react with other chemicals in the irrigation water to cause precipitation and plugging. Chemical reactions in the water can cause precipitates such as iron or calcium deposits to form. Plugging can be caused by either natural water conditions or by chemicals such as fertilizer added to the water. To avoid chemical clogging, the water should be analyzed to determine what chemicals are prevalent and which chemical additives should be avoided. Chemical water treatment may be required on a continuous or intermittent basis. Acids are sometimes used to prevent plugging and also to help renovate partially plugged emitters. The water source and the emitter size dictate the need for treatment. A thorough chemical analysis of the water source should be made prior to development of a SDI system.

Biological clogging problems may consist of bacterial slimes and algae. Some problems

can be eliminated in the filtration process, but an injection of a limited amount of chlorine into the driplines on a periodic basis is generally required to stop the biological activity. The source and composition of the water will determine, to a large extent, the need for chlorinating.

Micro irrigation will effect a change in plant growth and transpiration because of changes in the volume of soil water.

There may be a potential for development of saline seeps or other salinity problems resulting from increased infiltration near restrictive layers.

Field shape and slope frequently dictate the most economical lateral direction. Whenever possible, laterals should be laid downslope for slopes of less than 5% if lateral size reduction can be attained. For steeper terrain, lateral lines should be laid along the field contour and pressure compensating emitters should be specified or pressure control devices used along downslope laterals.

Percent plant wetted area (P_w) is not required on high water table soils when the water table is managed at a depth where capillary action (upflux) will supply a portion or the entire daily consumptive use rate.

Micro irrigation for windbreaks will not normally require the air and vacuum relief valves, and flushing at the end of the individual laterals is acceptable.

PLANS AND SPECIFICATIONS

Plans and specifications for the micro irrigation system shall be in keeping with this standard. The designer of the micro irrigation system (NRCS personnel, consulting engineer, equipment vendor, or others) shall furnish the owner with a complete set of plans and specifications covering all components of the system. The plans and specifications shall contain sufficient detail to allow the installation by person(s) unfamiliar with the project.

The plans and specification shall specify type, grades, quality, size, and construction materials of all equipment and appurtenances included in the system design.

These plans and specifications shall be checked for conformance with this standard prior to installation.

Specifications used for mainline and sub-main pipelines shall conform to the specifications and/or requirements listed for Irrigation Conveyance, Pipeline (430) for the selected pipe material.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan shall provide specific instructions for operating and maintaining the system to ensure that it functions properly, including reference to periodic inspections and the prompt repair or replacement of damaged components.

All micro irrigation systems shall be operated in accordance with an irrigation water management (IWM) plan, with the possible exception of micro irrigation systems for windbreaks. IWM plans shall be in accordance with Standard for Irrigation Water Management – Code 449 and provide an operation schedule as to when and how long to irrigate.

Frequent maintenance is essential to keep emitters functioning at design flow rate.

Typical maintenance items include:

- Clean or backflush filters when needed.
- Flush lateral lines regularly.
- Check applicator discharge often; replace applicators as necessary.
- Check operating pressures often; a pressure drop (or rise) may indicate problems.
- Check pressure gauges to ensure proper operation; repair/replace damaged gauges.
- Inject chemicals as required to prevent precipitate buildup and algae growth.
- Check chemical injection equipment regularly to ensure it is operating properly.
- Check and assure proper operation of backflow protection devices.

IRRIGATION SYSTEM, MICRO IRRIGATION (441)-6

- Repair of lateral line leaks caused by rodent or other damage.

REFERENCES

The following references may provide useful guidance and information in the development and application of micro irrigation systems:

National Engineer Handbook, Part 650,
Engineering Field Handbook

National Engineer Handbook, Part 652,
Irrigation Guide

National Engineering Handbooks, Part 623,
Section 15, Chapter 1-7 and 12.

National Engineering Handbooks, Part 634,
Section 15, Chapter 8, 11.

Water Measurement Manual - U.S.
Department of the Interior, Bureau of
Reclamation.

Neb-Guides – University of Nebraska

Irrigation Management Series Publications –
Kansas State University